A1

NASA-CR-200840

FJF 25677 Goldsmith H

NATIONAL ASTRONOMY AND IONOSPHERE CENTER

Reply to:
Office of the Director
Cornell University
Space Sciences Building
Ithaca, NY 14853-6801
Telephone: 607-255-3735
FAX: 607-255-8803

Arecibo Observatory
Post Office Box 995
Arecibo, PR 00613
Telephone: 809-878-2612
FAX: 809-878-1861

FINAL
IN-90-CR
OCIT.
43879

MEMORANDUM

TO: Tammy Custer
Administrative Specialist for Recording
120 Day Hall

FROM: Paul F. Goldsmith PFG/jtm
Director, NAIC

DATE: April 8, 1996

RE: Final Report on NASA Project NAG 5-2334

This project involved the study of clumpiness in the Monoceros R2 molecular cloud, and attempts to investigate the use of dust emission as well as gas tracers to study this. We have made substantial progress in developing the technique of dust temperature distribution determination by inversion of the emitted spectrum using the Mobius theorem. However, we found that the data available in general is not sufficient to allow this technique to be applied to such ends as searching for small-scale structure.

The Mobius technique for determining the dust temperature distribution was presented in a paper by Xie, Goldsmith, and Zhou (*Ap.J.*, **371**, L81, 1991). It offers the significant capability of taking the observed spectral distribution of dust emission, and from it finding the amount of dust at different temperatures. This obviously a very reasonable thing to do, inasmuch as we expect there to be major variations in dust temperature along lines of sight, especially those in the vicinity of embedded infrared sources and external heating sources such as HII regions. Determining the dust temperature distribution is important not only for understanding energetics of these regions, but for accurate determination of the dust column density. This is the case because the dust emission depends both on the dust temperature as well as its optical depth (or column density), and an incorrect assumption about dust temperature distribution will produce errors in the dust column density derived. In particular, assumption of single dust temperature, characterized by the 50 micron and 100 micron emission alone, for example, will overestimate the dust temperature and thus underestimate the dust column density.

In the first part of this project, we took the basic technique described by Xie, Goldsmith, and Zhou (1991) and applied it to a number of molecular cloud cores. We found that to get useful information from the technique, observations over a very wide range of wavelengths are required. Typically speaking, we need to get data from the submillimeter range to wavelengths well past the peak of the emission, meaning 20 microns or 10 microns wavelengths as the minimum. We were able to find such data for single lines of sight in five molecular clouds, including ones with modest as well as massive star formation. We were able to derive the dust temperature distribution, and the total dust column density. We feel that these results, presented by Xie, Goldsmith, Snell, and Zhou (*Ap.J.*, **402**, 216, 1993) represented a significant improvement in our ability to determine cloud column densities and masses from dust continuum emission.

Our attempts to pursue this technique at higher spatial resolutions using the IRAS data set were not as successful. The main problem is that with only the 50 micron and 100 micron data available, we did not have a sufficient range of wavelengths to constrain the dust temperature distribution. What will be of value is, in the future, to combine the IRAS Hires data with either the highest resolution single-dish submillimeter maps, or possibly submillimeter interferometric maps to obtain the required data.

This project has resulted in major improvement in our ability to analyze dust temperature distribution and determine cloud column densities and masses. It is also inspired other related approaches, including the maximum entropy method, to this task. Recently, there have been new data in the literature giving fairly high angular resolution maps of infrared sources (e.g. Colome and Harvey, *Ap.J.*, **449**, 656, 1995). We hope, in the future, to take advantage of this data and the inversion technique that we have developed to probe both the small-scale as well as the large-scale distribution of dust temperature in molecular clouds.

xc: E. Bartell